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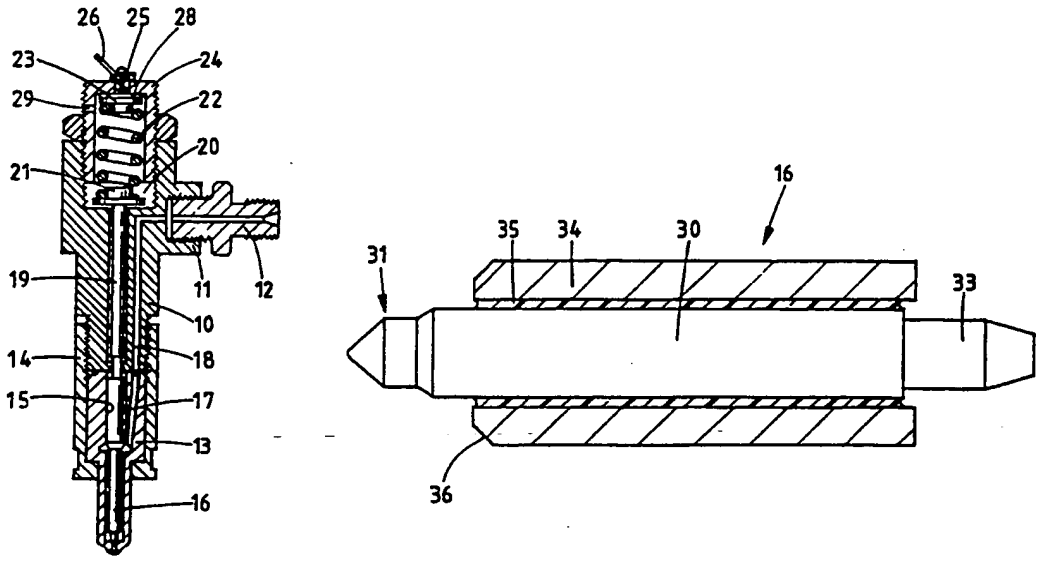

(57) Abstract

A fuel injection nozzle has a valve member (16) slidable in a bore (15) in a nozzle body (13). The valve member has an end profile(31) shaped to engage a seating at the end of the bore. The valve member has an electrically conductive elongated core member (30) which at one end defines the profile (31) and is surrounded in spaced relationship by a metallic sleeve (34) which guides the movement of the valve member in the bore. The sleeve is bonded to the core member by a layer (35) of electrically insulating material conveniently a ceramic, whereby the elongated member is electrically insulated from the nozzle body except when the valve member is in the closed position.

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FUEL INJECTION NOZZLES

This invention relates to fuel injection nozzles for supplying fuel to an internal combustion engine the nozzles being of the kind comprising a valve member slidable within a bore formed in a nozzle body, a seating defined at one end of the bore, the valve member being shaped for cooperation with the seating to prevent fuel flow from a fuel inlet to an outlet.

Such nozzles are well known in the art and the valve member is usually resiliently loaded to the closed position and movable away from the seating against the action of the resilient loading, by the action of fuel under pressure supplied to the inlet. In modern fuel injection systems for internal combustion engines it is desirable to know the instant at which the valve member moves away from the seating in order that the timing of delivery of fuel to the engine can be closely controlled.

It has been proposed to provide sensors in the holder to which the nozzle body is secured, which sensors provide an electrical signal upon movement of the valve member. In some cases the sensors are responsive to the movement of the valve member and in other cases to an increase in the stress in the spring biasing the valve member. The provision of such sensors is inconvenient and it has been proposed to use the valve member and the seating as a simple electrical switch. This requires that the valve member should be electrically insulated from the wall of the bore in which it is located. British patent specification 2125894 describes a method of achieving the desired insulation in which a coating of insulating material is provided on the valve member or in the bore in which it is located. This method has not proved to be entirely reliable due to the difficulty of finding a suitable coating material which can withstand

the heat and pressures to which the nozzle is subject to in use.

The object of the present invention is to provide a fuel injection nozzle of the kind specified in a simple and convenient form.

According to the invention in a fuel injection nozzle of the kind specified said valve member comprises an elongated cylindrical member which at one end is shaped for cooperation with the seating and is formed from electrically conductive material, a metallic sleeve located in spaced relationship about the member and a layer of electrically insulating material disposed between the sleeve and member and which forms a bond between the member and the sleeve, said sleeve in use cooperating with the wall of the bore to guide the movement of the valve member, said elongated member being electrically insulated from the nozzle body except when it is in contact with the seating.

The invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a sectional side elevation of a known form of fuel injection nozzle,

Figure 2 is an enlarged view of a portion of the nozzle seen in Figure 1,

Figure 3 is a part sectional side view to an enlarged scale of part of the nozzle seen in Figure 1 and modified in accordance with the invention and

Figure 4 is a view showing a modified form of the part seen in Figure 3.

Referring to Figure 1 of the drawings, the nozzle comprises a holder 10 which is of generally cylindrical form and which is provided with a lateral extension 11 having a threaded aperture which receives a pipe union 12 which constitutes the fuel inlet for the nozzle. At one end of the holder 10 there is secured a valve body 13 which is of stepped cylindrical form. The narrower end portion of the valve or nozzle body projects in use, through the wall of a combustion space of an engine and the nozzle body is retained relative to the holder in known manner, by a cup shaped retaining member 14 having an aperture formed in its base wall through which the narrower portion of the nozzle body extends.

Formed within the nozzle body 13 is a bore 15 and this extends to adjacent the end of the narrower portion of the nozzle body and defines a seating for a valve member 16 which is slidable within the bore. The valve member is shaped for cooperation with the seating to prevent flow of fuel through outlet orifices which communicate with the blind end of the bore. The valve member 16 is of stepped form, the narrower portion of the valve member lying generally within the portion of the bore 15 which is formed in the narrower portion of the nozzle body. There is defined between the valve member and the bore a clearance which is connected by cooperating passages 17, 18 in the nozzle body and the holder respectively with the aforementioned fuel inlet.

Formed in the holder 10 is an axially extending drilling which accommodates with clearance, a push rod 19 of a spring abutment. The push rod is engaged about an

axial projection on the valve member and at its other end opens into an enlarged chamber 20 and at this end is provided with an abutment element 21 for resilient means in the form of a coiled compression spring 22. The other end of the coiled compression spring is engages about a further abutment 23 which is turn engages a cup shaped member 24 which is in screw thread engagement with the wall of the chamber 20. The cup shaped member 24 is prevented from rotation in the holder, by a lock nut and an aperture 29 is provided to allow fuel leakage from the chamber 20. In operation, when fuel under pressure is admitted to the clearance defined between the valve member and the bore 15, the valve member is moved against the action of the spring 22, to permit fuel flow through the aforesaid outlets and when the supply of fuel under pressure ceases the valve member is returned into contact with the seating by the coiled compression spring. Any fuel which leaks between the working clearance defined between the valve member and the wall of the bore 15, accumulates in the chamber 20 and can flow to a drain. The maximum extent of movement of the valve member against the action of the spring is limited by the engagement of the valve member with the end surface of the holder.

In order to provide an indication of the movement of the valve member 16 away from the seating, the valve member has a special construction which will be described. The push rod 19 is formed from metal and has an electrical connection with the central part of the valve member which engages the seating. The push rod and the spring 22 together with the abutment 21 are spaced from the walls of the holder and cup shaped member 24 respectively and the abutment 23 is electrically insulated from the cup shaped member 24 by means of an

electrically insulating disc 28 so that the only direct electrical connection between the valve member and the holder occurs when the valve member is in contact with the seating. The abutment 23 has secured thereto an electrical conductor 27 which passes through an insulating collar 25 locating within an aperture in the base wall of the cup shaped member and it is connected to an electrical connector 26 which in use is connected to an electrical circuit forming part of the engine management system.

Turning now to Figure 3 the valve member 16 comprises a centrally disposed elongated cylindrical metallic member 30 which at one end is provided with a truncated profile 31 for engagement with the seating.

The member 30 at its opposite end is provided with the aforesaid axial projection 33 which extends with clearance through an opening in the adjacent end surface of the holder for engagement by in the particular example, the push rod. Surrounding the member 30 in spaced relationship is an outer member in the form of a metallic sleeve 34 the outer surface of which co-operates with the wall of the bore 15 to guide the movement of the valve member. The sleeve is secured relative to the member by means of an electrically insulating ceramic layer 35 which forms a bond with the metallic material forming the member and the sleeve. One such material which can be used is that which is sold under the trade name MONITOX by Monitor Coatings and Engineers Limited of Wallsend, Tyne and Wear, England.

As will be seen from Figure 3 the sleeve 34 projects beyond the step defined between the member 30 and the projection 33 in the direction of the projection,

whereby in the fully open position of the valve member the sleeve 34 engages the end surface of the holder 10 to limit the movement of the valve member. Since the sleeve is electrically insulated from the member 30, the member 30 remains insulated from the nozzle body in the fully open position of the valve member. At its opposite end the sleeve is conveniently provided with a chamfer 36. It will be appreciated that the fuel under pressure also acts upon the end surface of the sleeve 34 as well as on the elongated member 30 and that the force which is developed on the sleeve by the fuel under pressure is applied to the member 30 through the bond established by the layer 35.

In some forms of nozzle a distance piece is located between the nozzle body and the holder and in this form of nozzle the distance piece defines the surface which is engaged by the sleeve 34 to limit the movement of the valve member.

The material is described as a ceramic based on a complex chromia-silica matrix interspersed with hard alumina particles.

Figure 4 shows a modified form of the valve member 16 in which the member 37 having at one end the profile 31 for engagement with the seating is provided adjacent its other end with a flange 38. Located against the end surface of the flange presented to the holder is an electrically insulating washer 39 which when the valve member is in its fully open position engages with the end surface of the holder. Intermediate the flange 38 and the end portion of the member defining the profile 31 is an electrically insulating layer 41 which is surrounded by a metallic sleeve 40. The sleeve 40 co-operates with

the wall of the bore 15 to guide the movement of the valve member and the layer bonds the sleeve to the member 37. The layer also extends to provide insulation between the end of the sleeve and the flange 1.

The layers 35 and 41 may be formed by locating the members within the sleeves in the desired spaced relationship and introducing the ceramic material into the gap between the presented surfaces. The ceramic is subjected to a thermo-chemical treatment the effect of which is to form a molecular bond with the metal of the member and sleeve to thereby secure the two members together. After bonding the sleeve can be machined to the desired diameter and the profile 31 established.

The ceramic may be introduced into the gap through apertures formed in the wall of the sleeve intermediate the ends thereof. This having the effect of minimising the porsity of the layers 35 and 41.

By the construction described the desired electrical insulation of the member 30 from the nozzle body when the valve member is lifted from the seating is obtained so that the equivalent of a simple electrical switch is obtained which is opened a soon as the valve member is lifted from the seating.

CLAIMS

1. A fuel injection nozzle for supplying fuel to an internal combustion engine comprising a valve member (16) slidable within a bore (15) formed in a nozzle body (13), a seating defined at one end of the bore and the valve member being shaped for co-operation with the seating to prevent fuel flow from a fuel inlet (12) to an outlet characterised in that the valve member (16) comprises an elongated member (30, 37) which at one end has a profile (31) for co-operation with the seating and is formed from electrically conductive material, a metallic sleeve (34, 40) located about the member (30, 37) in spaced relationship, and a layer (35, 41) of electrically insulating material disposed between the member and the sleeve, the material of said layer forming a bond between the member and the sleeve, whereby the member (30, 37) is electrically insulated from the nozzle body (13) except when it is in contact with the seating.

2. A nozzle according to Claim 1, in which the material forming said layer is a ceramic.

3. A nozzle according to Claim 1 or Claim 2 in which said elongated member defines an axial projection (33) upon which is mounted a spring abutment (19, 21), the spring abutment being located with clearance within a holder (10) to which it nozzle body is secured, the sleeve (34) engaging in use, with a surface defined by said holder (10) or with a part located between the nozzle body and the holder, to limit the movement of the valve member away from the seating.

4. A nozzle according to Claim 1 or Claim 2, in which said elongated member (37) is provided with a flange (38) adjacent its end remote from the profile (31), said layer extending to provide insulation between the end of the sleeve and the flange.

5. A nozzle according to Claim 4, including an insulating washer (39) mounted adjacent said flange (38) said washer engaging in use, with a surface defined by a holder (10) to which the nozzle body (13) is secured or with a surface defined on a part located between the holder and the nozzle body, to limit the movement of the valve member away from the seating.

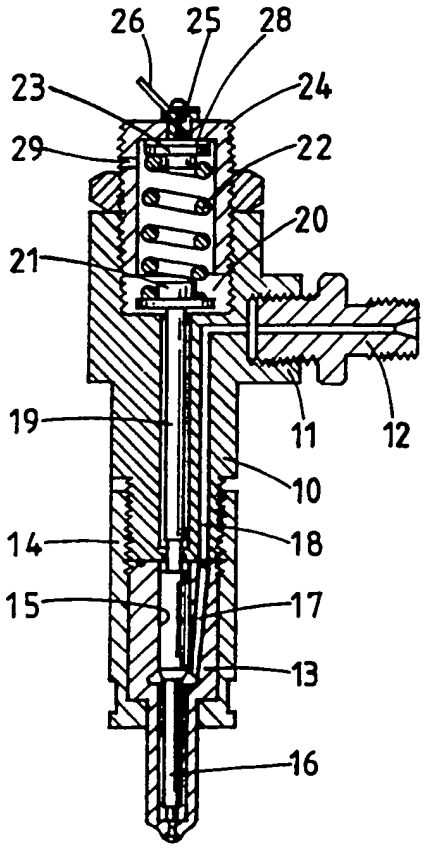

FIG. 1.

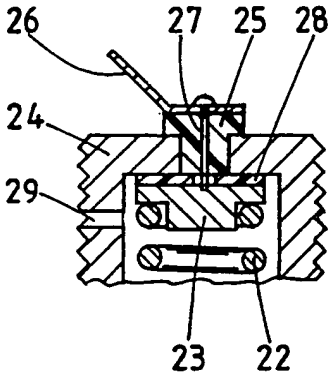

FIG. 2.

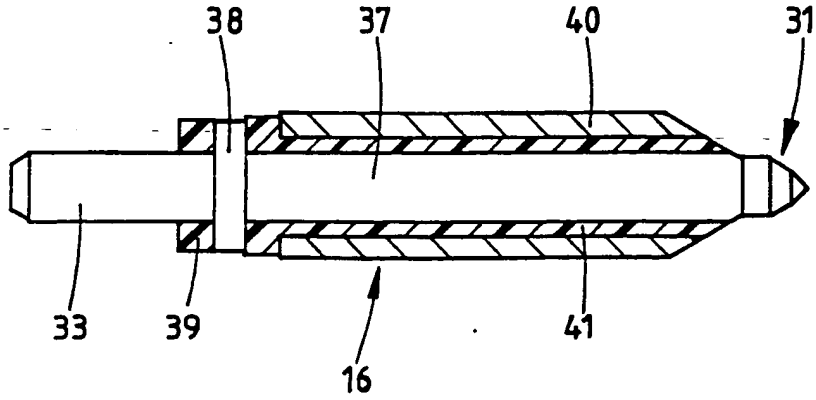

FIG. 4.

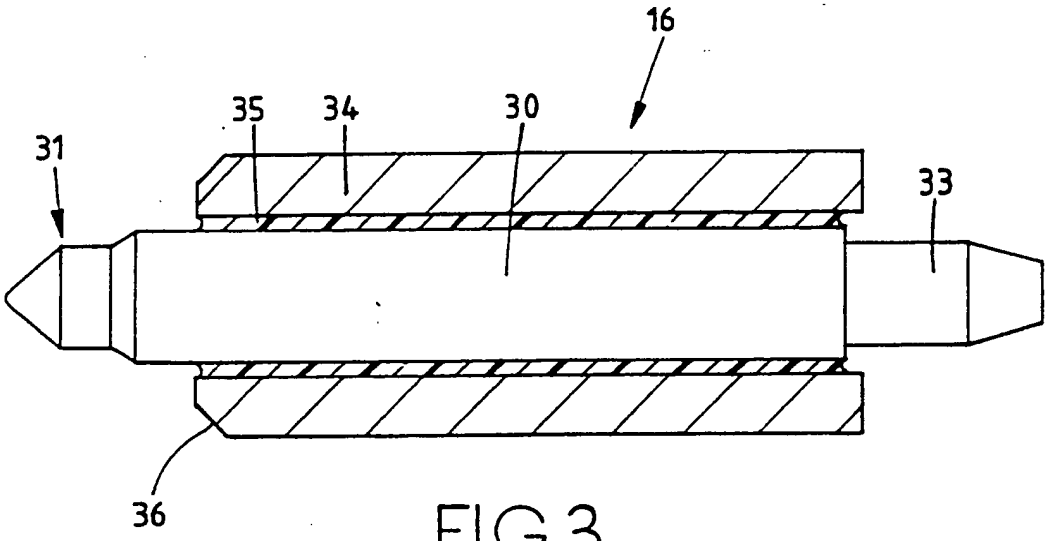

FIG.3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/01532

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F02M65/00; F02M61/16

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F02M

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	EP,A,0 020 888 (ROBERT BOSCH GMBH) 7 January 1981	1
Y	see page 5, line 25 - page 6, line 11; figure 2	2-4
Y	DE,A,3 445 721 (DIESEL KIKI CO. LTD.) 4 July 1985 see page 9, line 16 - line 35; figure 2	2
Y	US,A,4 625 918 (T. FUNADA ET AL.) 2 December 1986 see column 3, line 31 - column 4, line 48; figures 1-3	3,4
A	GB,A,2 097 859 (ROBERT BOSCH GMBH) 10 November 1982 see the whole document	1,3

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14 JANUARY 1992	24. 01. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT FFICE	HAKHVERDI M.

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim N
A	EP,A,0 045 530 (ROBERT BOSCH GMBH) 10 February 1982 see the whole document ---	1,3

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9101532 SA 51128

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 14/01/92
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